

# SUPPORTING INDUSTRIES

## Project Fact Sheet



## ENHANCEMENT OF ALUMINUM ALLOY FORGING

### BENEFITS

- Potential national energy savings of  $2.1 \times 10^{10}$  Btu/year

### APPLICATIONS

The forging technology will reduce forging energy consumption and environmental impacts in the aluminum, chemicals, metal casting, and steel industries. It will decrease cycle time and gaseous emissions, and increase energy efficiency in the forging, heat treating and process heating industries.

## A HYBRID RAPID PREHEATING TECHNOLOGY FOR REFINING GRAIN SIZE OF ALUMINUM BILLETS

Conventional gas fired convection furnaces used for forging aluminum and titanium parts require long heating times, sometimes in excess of an hour, which causes an overgrowth of the internal grains and the dissolution of the intermetallic particles, both resulting in a large grain size. Also, these furnaces use excessive energy to heat forged stock and must be kept at high temperatures for long periods of time to remain available at short notices. In contrast, a new hybrid infrared furnace will be developed which will heat aluminum and titanium billets in an order of magnitude useable only as needed. Its rapid heating feature will provide U.S. industries, particularly the automotive industry, the ability to redesign parts made with thinner sections, achieving significant energy savings due to lower requirements of both stock and weight. With a conversion efficiency of 90% of its heating elements, and its additional ability to rapidly heat large batch sizes with varied diameters, the new hybrid infrared furnace will permit continuous billet heating and lean manufacturing, and therefore could become the replacement furnace of choice for the aluminum and titanium forging plants.

### INFRARED BILLET HEATING



00-1584-01 Finished T-6 Heat Treatment  
50X 100µm  
100H<sub>2</sub>O / 2g Na<sub>2</sub>MoO<sub>4</sub>·2H<sub>2</sub>O / 2g NH<sub>4</sub>HF<sub>2</sub> / SHCL

Convection Heated/Forged and T-6 Heat Treated



00-1582-03 QC Force 40Min. T-6 Heat Treatment  
50X 100µm  
100H<sub>2</sub>O / 2g Na<sub>2</sub>MoO<sub>4</sub>·2H<sub>2</sub>O / 2g NH<sub>4</sub>HF<sub>2</sub> / SHCL

Infrared Heated/Forged and T-6 Heat Treated

Illustration of infrared billet heating resulting in finer grain size forgings.



## Project Description

**Goal:** The objectives of this research are to:

- Identify mechanisms and rates of rapid billet preheating in forging operations, to attain substantial refinement in grain size for aluminum alloy billets compared to that attainable by convection heating.
- Establish improvement in mechanical properties produced by the grain refinement attained.
- Design, construct and implement the hybrid rapid heating technology for billets.

## Progress and Milestones

- Project start date, August 2001.
- Project end date, August 2004.
- Year 1: The hybrid infrared furnace, capable of heating from cold start in less than 1 second, will be designed and constructed. Initial heating experiments will be run on metal samples. Samples will be forged and studied to understand how infrared heating will affect forging stock metallurgy.
- Year 2: Experiments will be conducted on forging stock samples under various heating conditions, followed by forging operations. Each sample will be field tested at industrial sites to determine how infrared processing affected mechanical properties.

## Commercialization Plans

To be determined.



### PROJECT PARTNERS

Forging Industry Association  
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